The Case for PBMA

Mark Brown

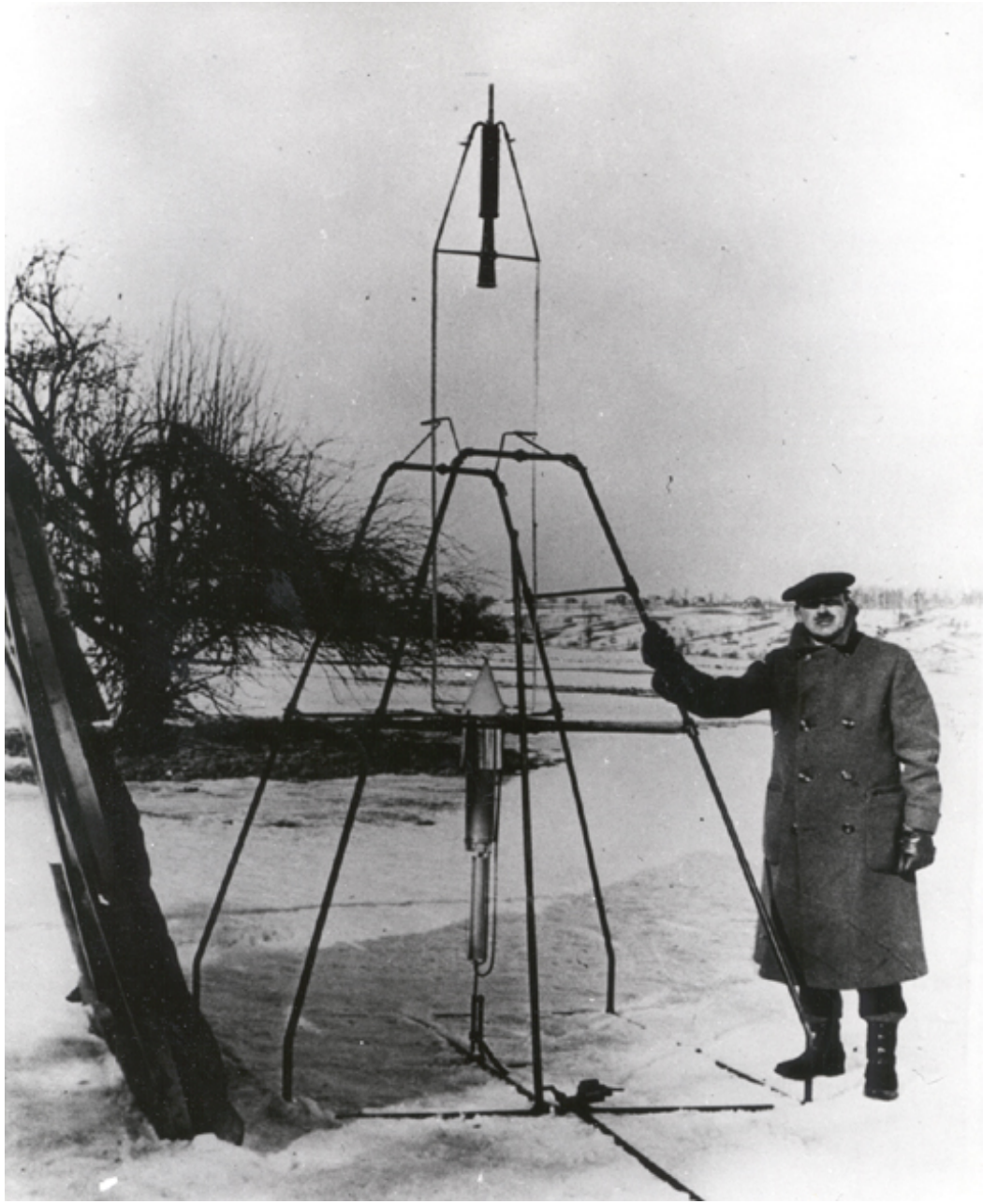
The PBMA Framework

Program Management	Concept Development	Acquisition	Hardware Design	Software Design	Manufacturing	Integration & Test	Operations	
1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	Policies
1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	Plans
1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	Processes
1.4	2.4	3.4	4.4	5.4	6.4	7.4	8.4	Program Control
1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	Verification & Testing

What is the fundamental goal of PBMA?

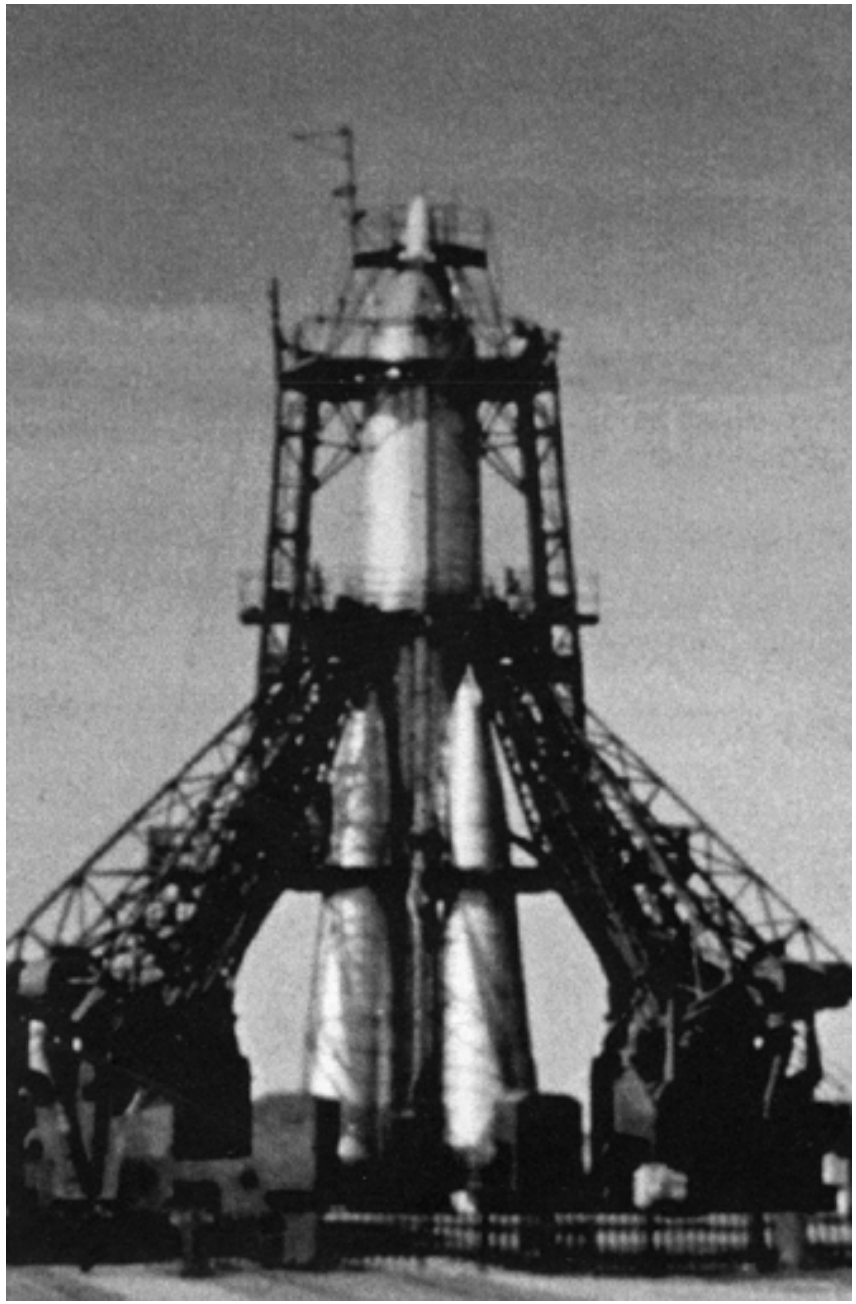
“The efficient sharing of information across space and time”

Beginnings…



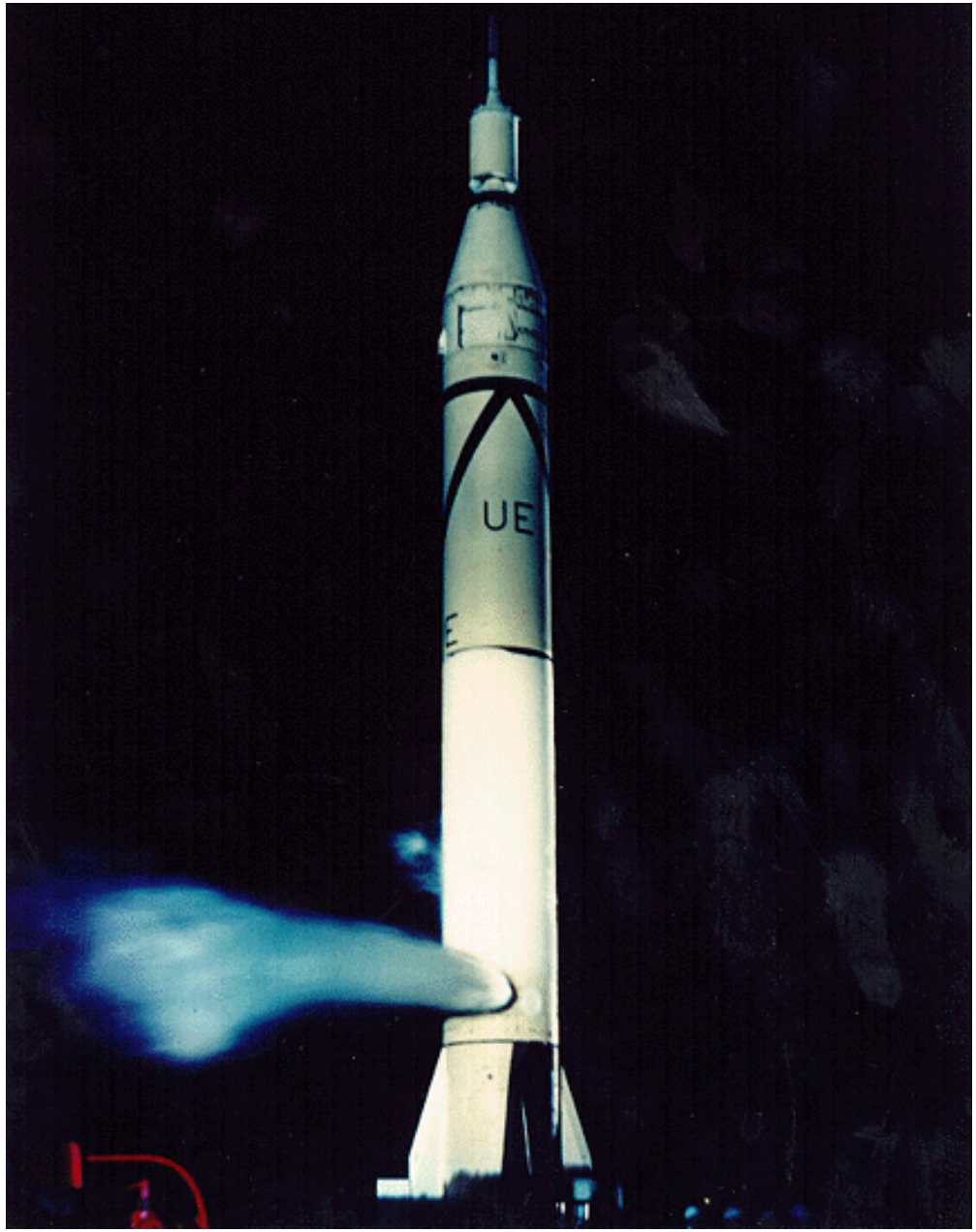
Dr. Robert Goddard was the “Father of American Rocketry” and developed the first liquid fueled rocket in 1926

Just like the airplane, many things in rocketry were learned through trial and error



The space race began in 1957 with the launch of Sputnik 1 by the Soviet Union

Sputnik 1 was a small satellite measuring 22 inches in diameter and weighing only 183 pounds



The U.S. launched its first satellite ,Explorer 1, on a Jupiter-C rocket in 1958. The Jupiter-C had a total thrust at lift off of 83,000 pounds.

Explorer 1 was also a small satellite weighing only 30 pounds

The Huntsville Times

Man Enters Space

'So Close, Yet So Far,' Sighs Cape

U.S. Had Hoped For Own Launch

Soviet Officer Orbits Globe In 5-Ton Ship

Maximum Height Reached Reported As 188 Miles

Hobbs Admits 1944 Slaying

Praise Is Heaped On Major Gagarin

First Man To Enter Space Is 27, Married, Father Of Two

'Worker' Stands By Story

Reds Deny Spacemen Have Died

To Keep Up, U. S. A. Must Run Like Hell'

No Astronaut Signal Received At Ft. Monmouth

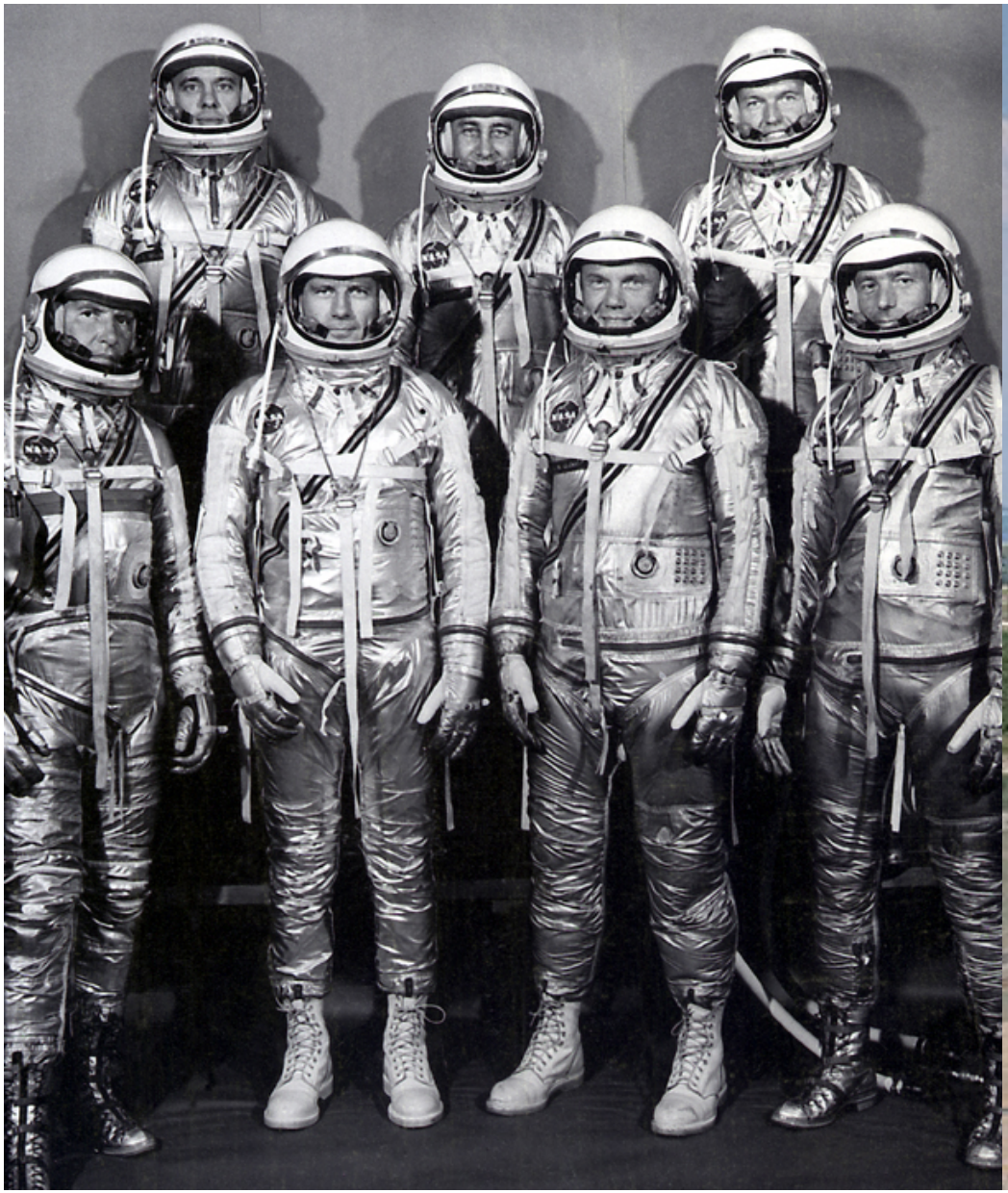
Reds Win Running Lead In Race To Control Space

In 1961 the Soviet Union launched the first man into space. Major Yuri Gagarin's sub-orbital flight lasted 48 minutes

Characteristics of the Early Years

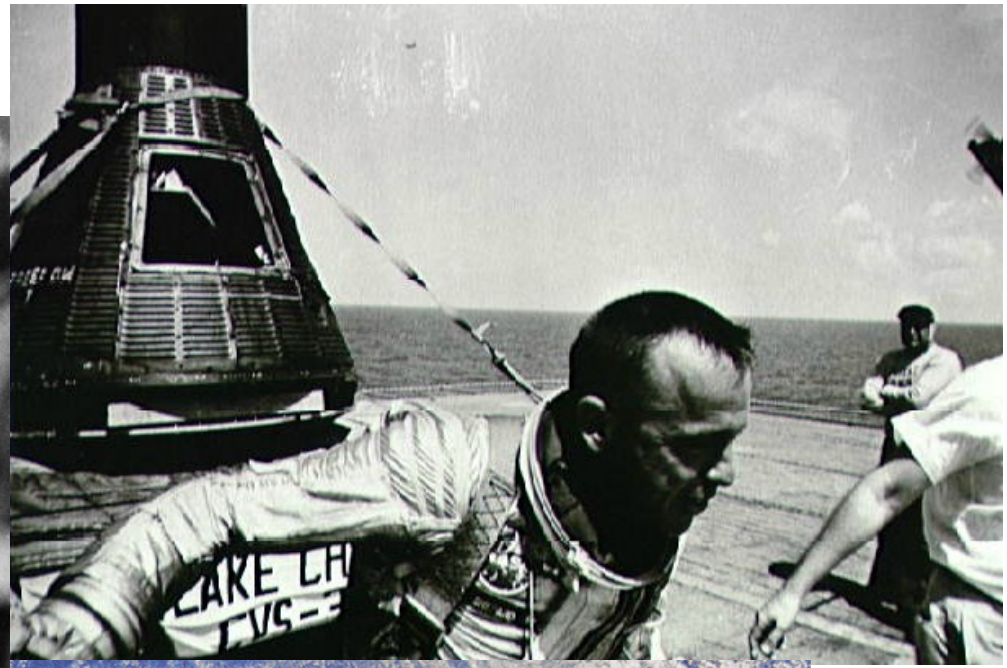
- **Small, dedicated, permanent teams**
- **Primarily R&D with very limited operations**
- **Simplistic, unmanned systems**
- **Pass/Fail operations**
- **One time use vehicles**
- **Negligible training**

Mercury
1961-1963

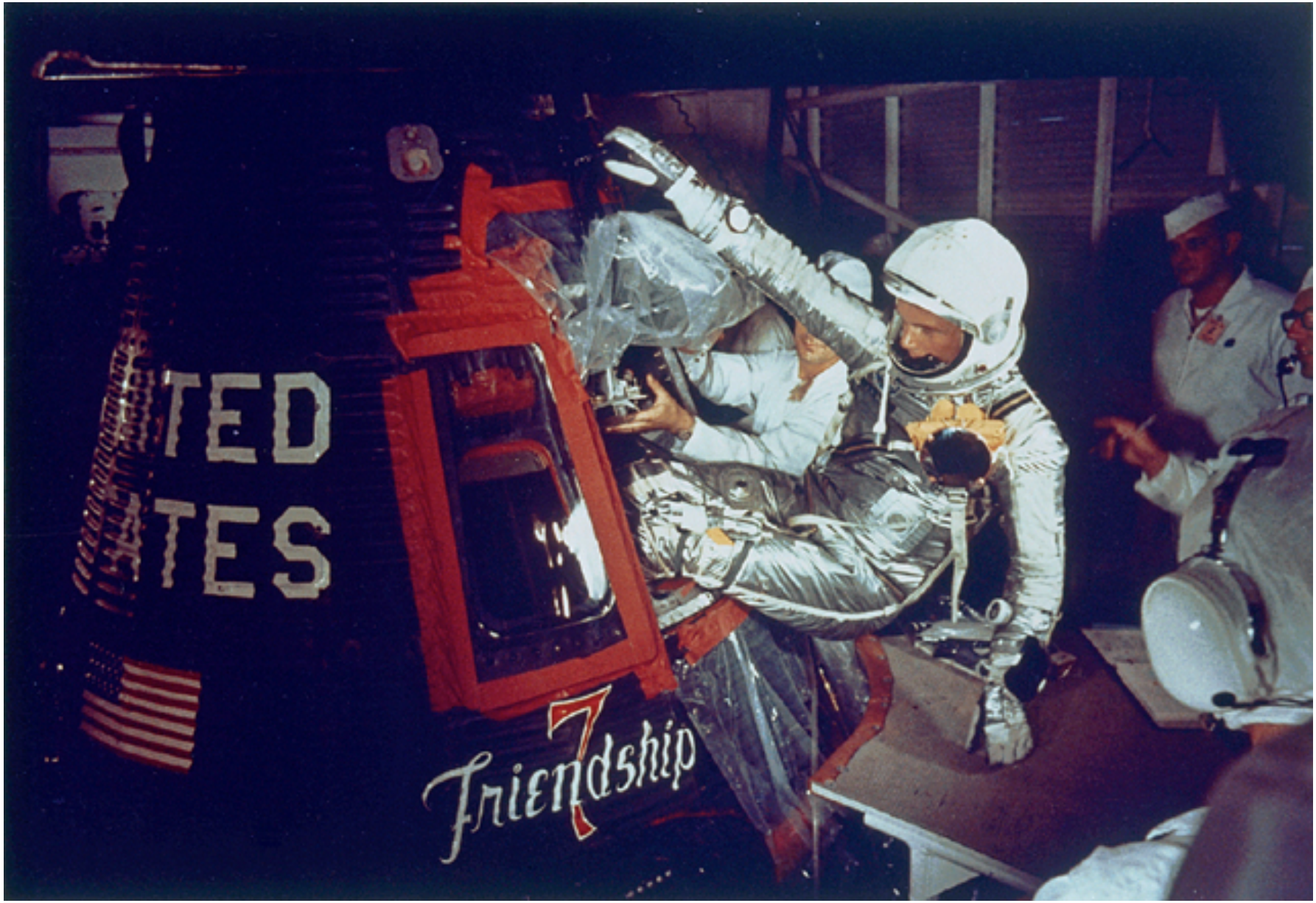


The original 7 astronauts were selected by NASA in 1959. The first man-rated rocket was the Mercury Redstone with 78,000 pounds of thrust.

The first astronaut to ride the Redstone was Ham the chimp in 1961.



The first American in space was Alan Shepard in 1961. His flight was also sub-orbital and lasted 15 minutes and 22 seconds.



John Glenn made the United State's first orbital flight in 1962

Glenn rode on the Mercury Atlas rocket with a total thrust of 367,000 pounds

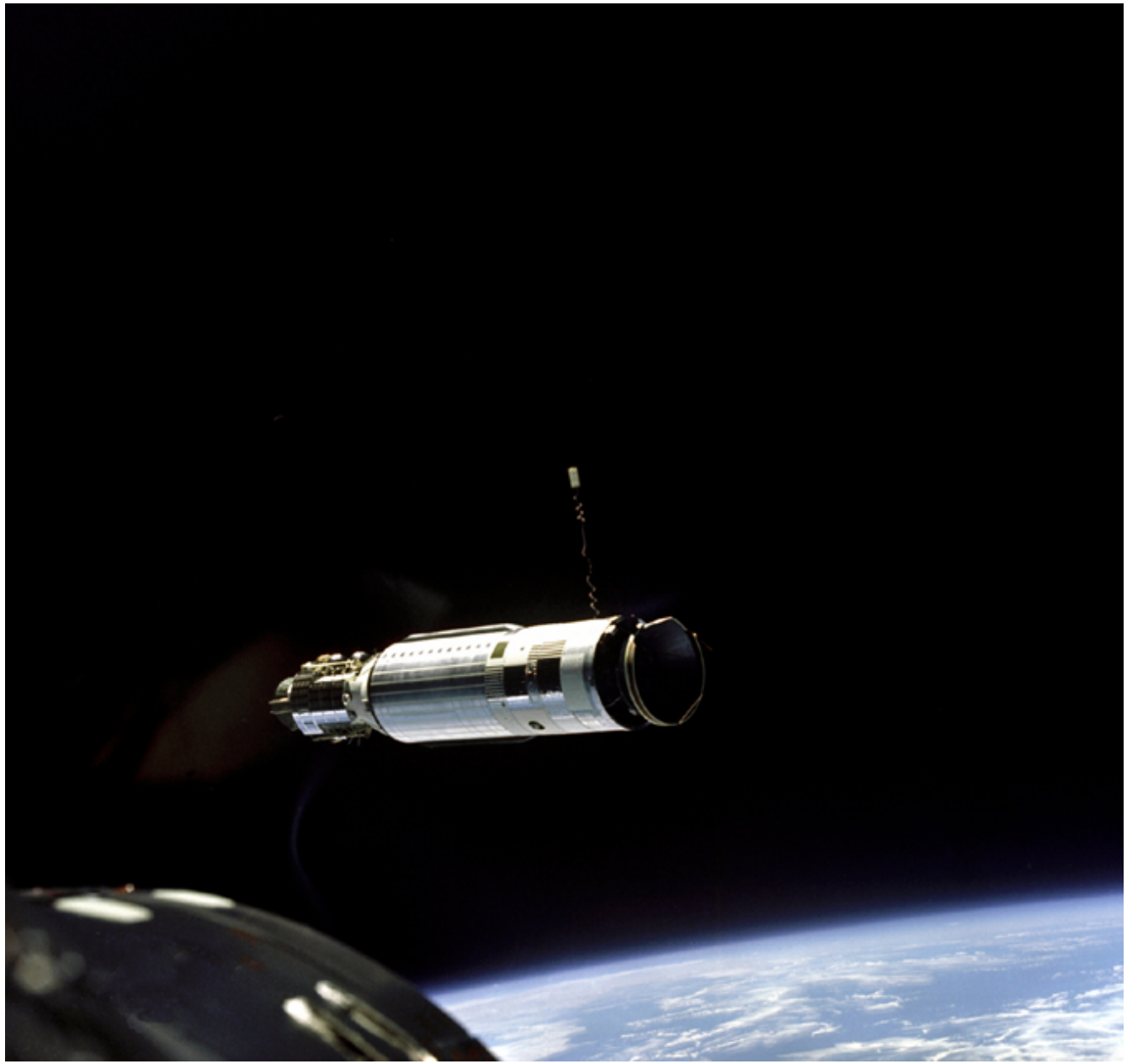
Gemini
1965-1966

The Gemini program continued the advance of technology to access space.
The Gemini Titan rocket produced 430,000 pounds of thrust.

The Gemini capsule carried a crew of two with little room for extra equipment. Pictured are Neil Armstrong and Dave Scott in Gemini 8.

Gemini saw the first rendezvous of two spacecraft in orbit

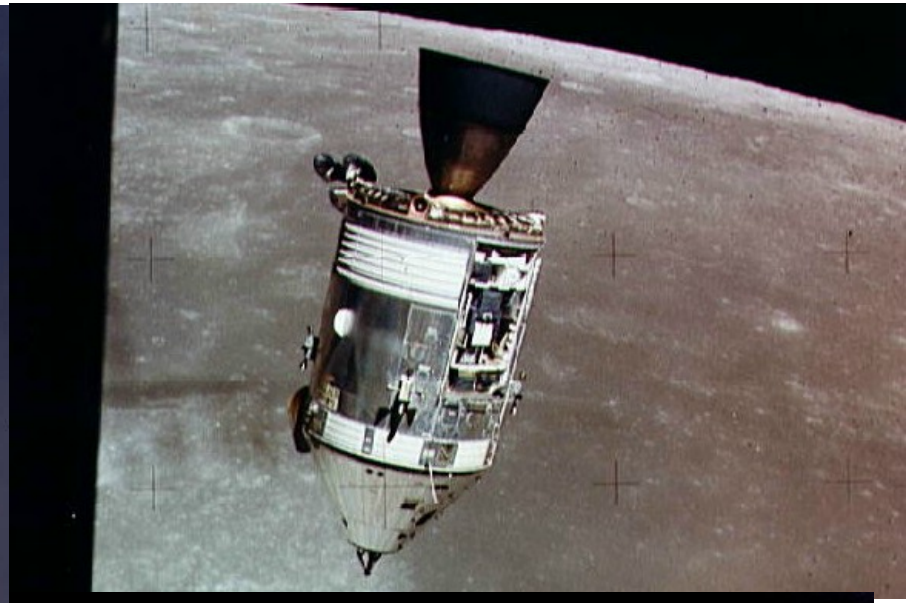
The first U.S. spacewalk was conducted in 1965 by Ed White.

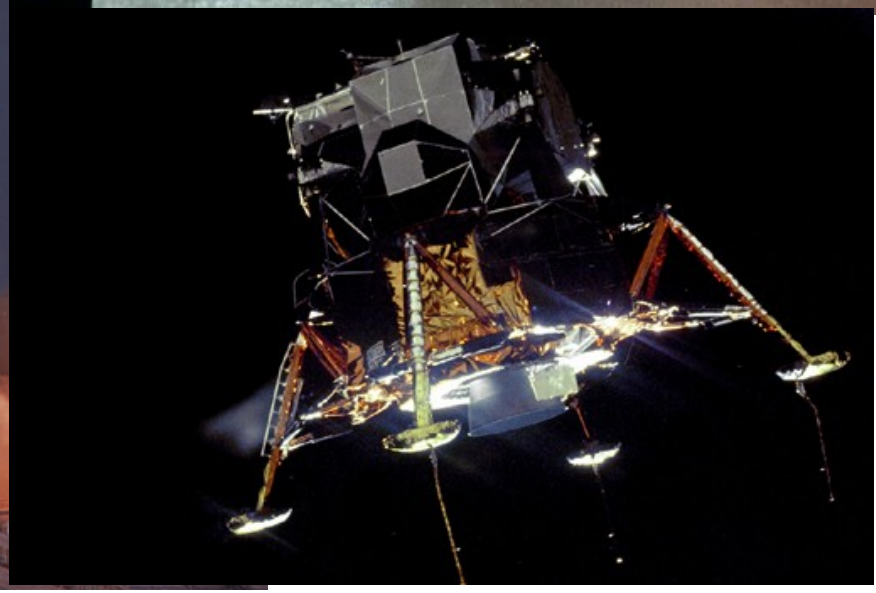


The first docking of two vehicles was accomplished using the Agena Target Vehicle

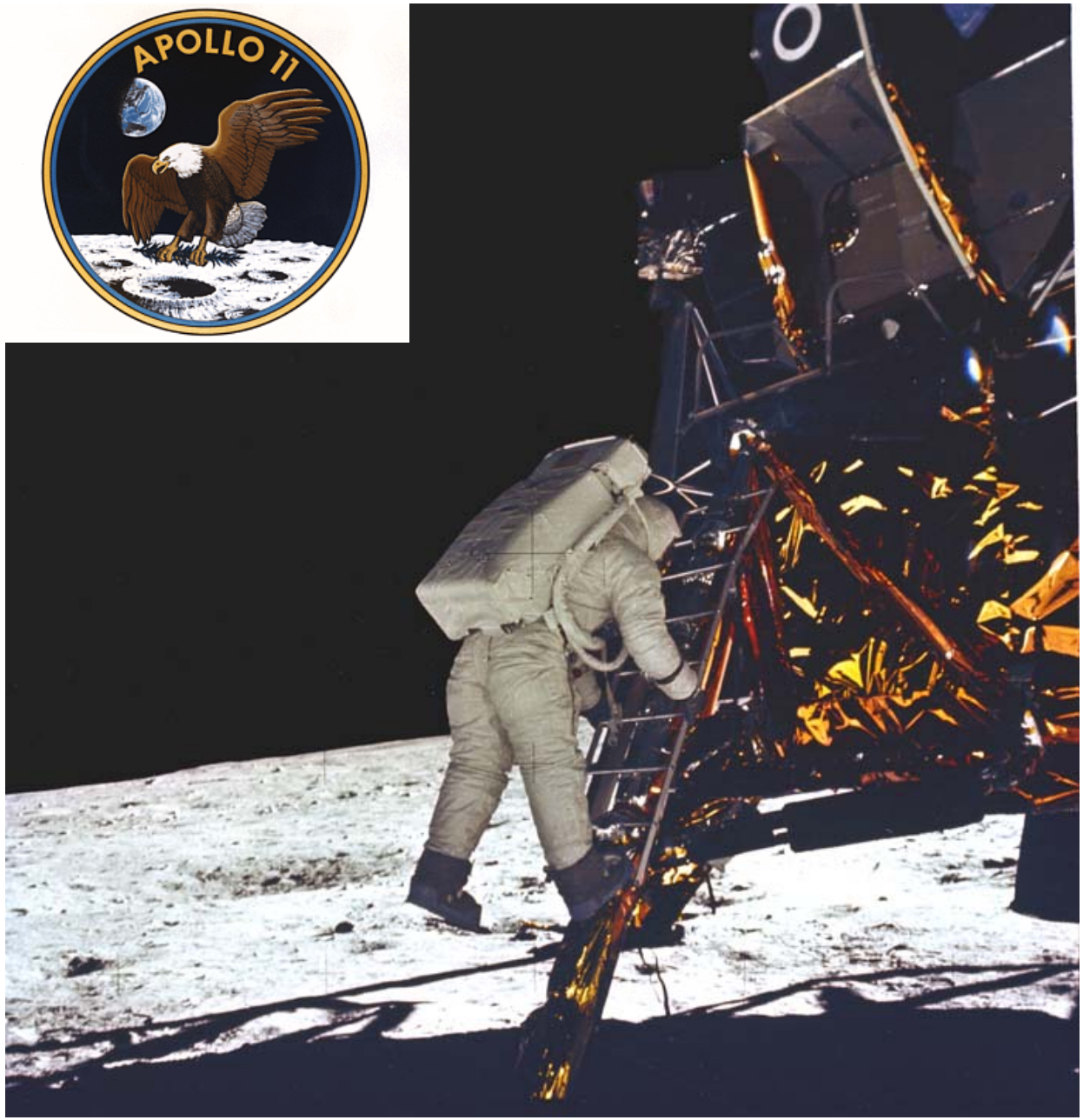
Gemini still required a re-entry using ablative heat shields subjecting the crews to high G loading, and parachute landings in the ocean.

Apollo
1968-1972



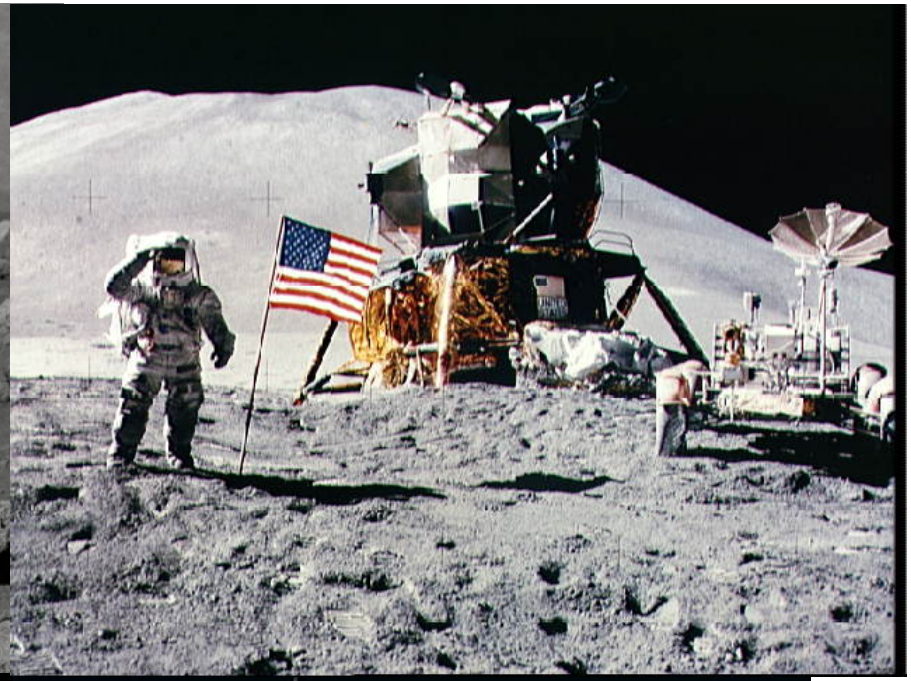


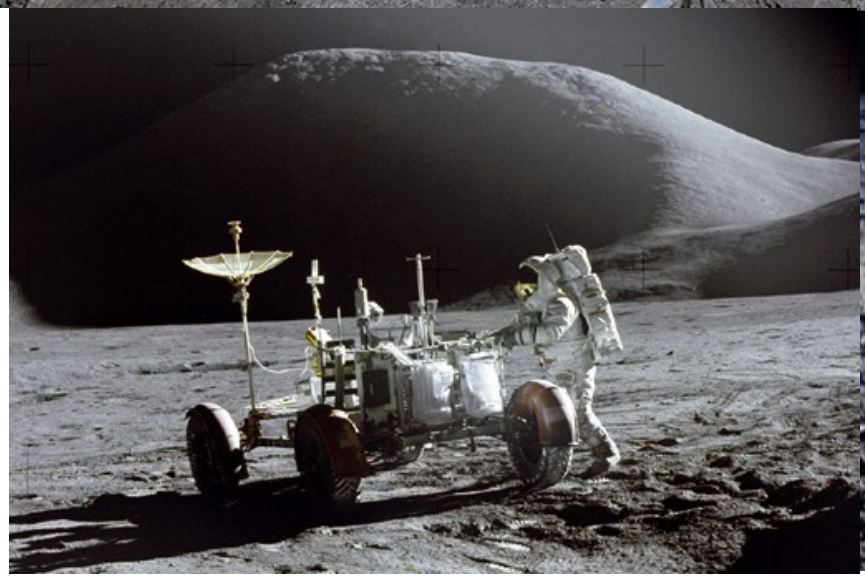
Apollo required new equipment to go to the moon. The Saturn V rocket producing 7.8 million pounds of thrust, a command and service module, plus a lunar lander.

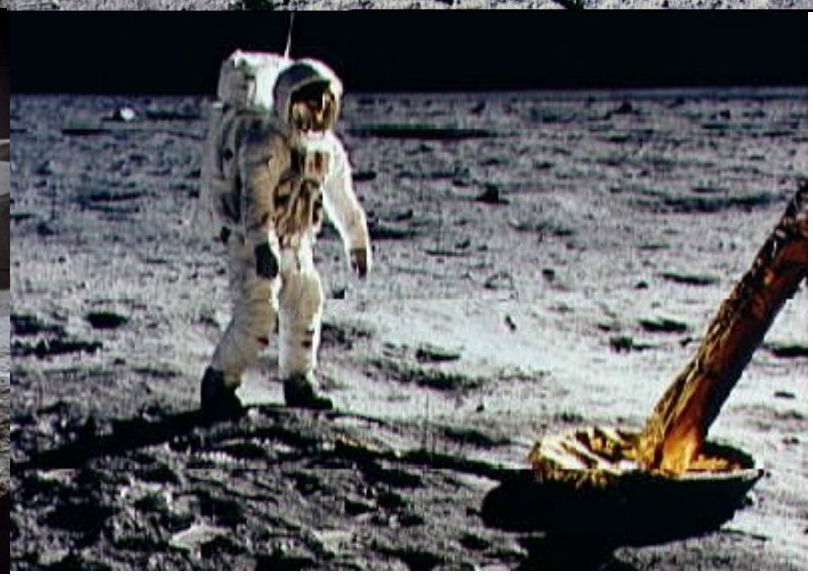


The first moon landing occurred on July 20th, 1969.

“One small step for a man, one giant leap for mankind.”







The Apollo missions were our first opportunity to live and work on the surface of another body.

The last moon mission was Apollo 17 in December 1972.

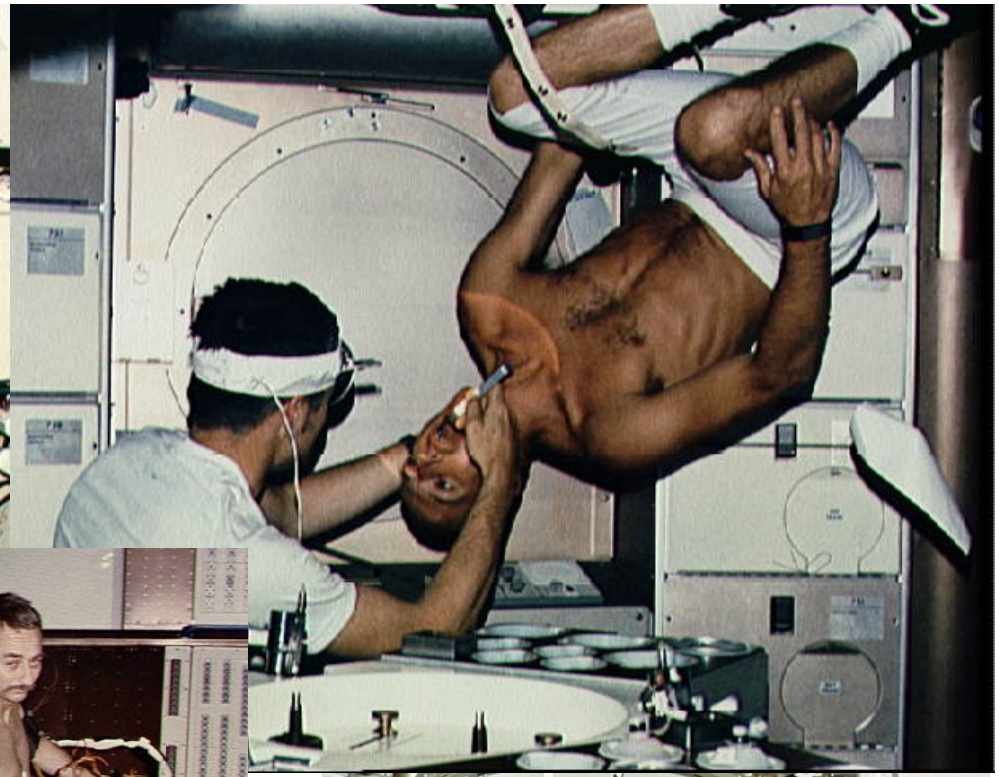
Characteristics of the Apollo Era

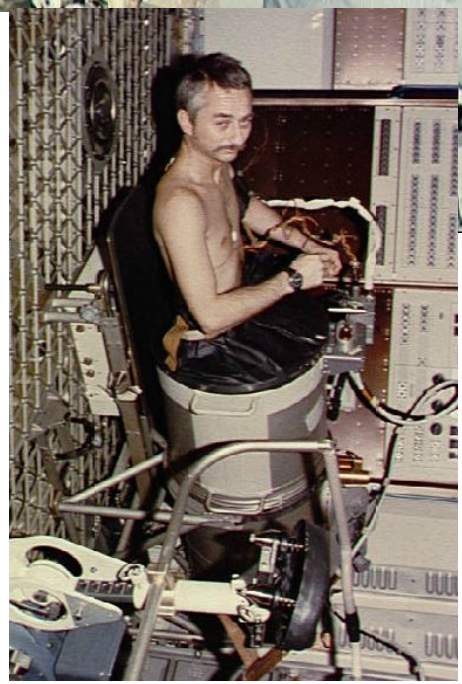
- Large, dedicated, semi-permanent teams
- Primarily R&D with limited operations
- First sophisticated systems in space
- Pass/Fail operations not acceptable
- Lives lost in training and in flight
- One time use vehicles
- Development of integrated training
- Massive knowledge gains over 10 year period
- A completely paper-based system

Skylab
1973-1977

The first U.S. space station, Skylab, was launched in 1973.

The Skylab program only included three missions of 28, 59, and 84 days in duration.



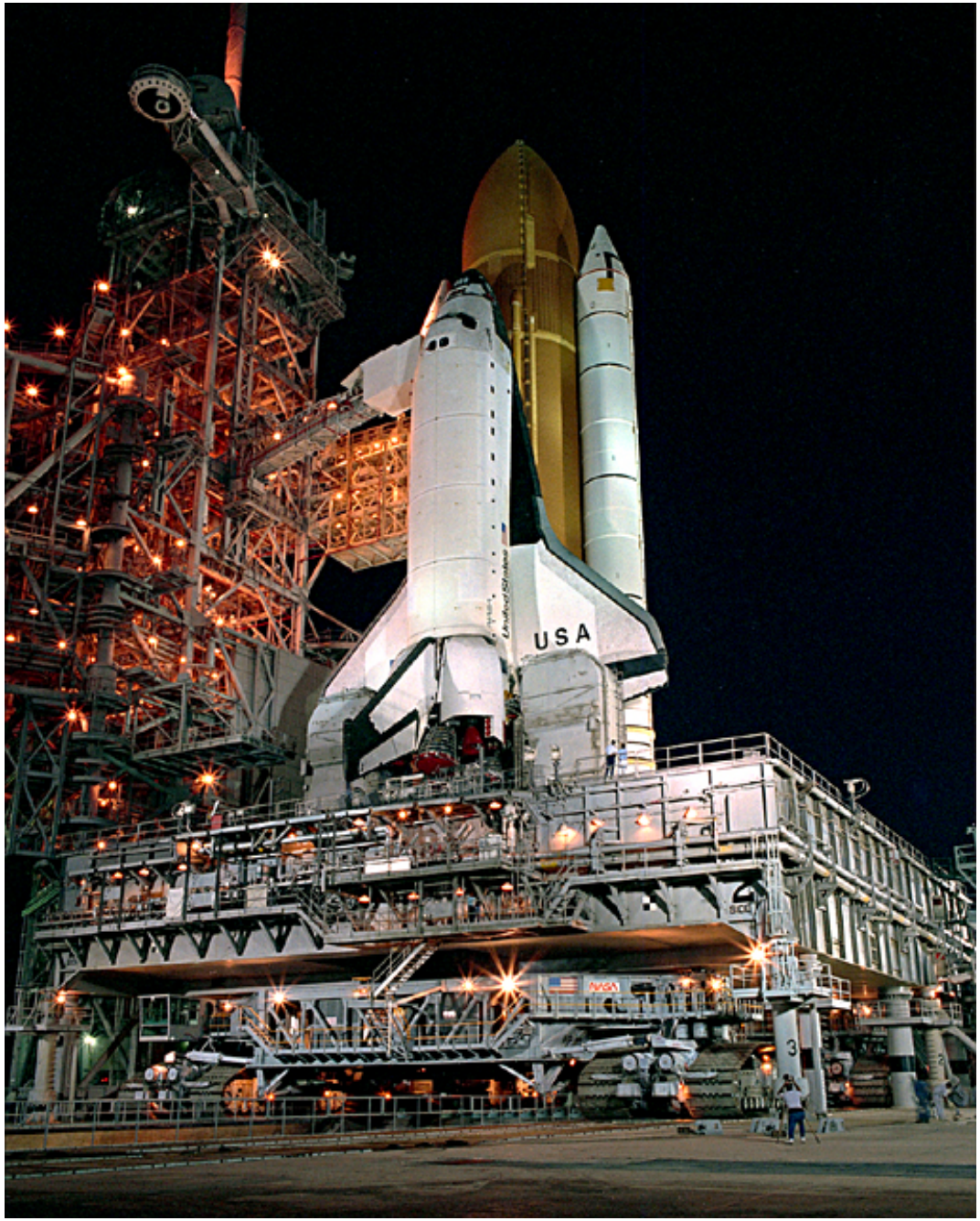


Although limited, it was our first real opportunity to study the long duration effects of weightlessness while living and working in space.

Transition

- First prolonged operational experiences
  - 28, 59, and 84 days
- Emergence of totally news issues
  - Long term system performance, repair, spares…
  - Extensive training on systems and experiments prior to flight
  - Human factors in scheduling and interpersonal relations (on the ground and on orbit)
  - Adverse effects of long-term exposure to 0-G
- Paper based system not adequate
- Considerable turnover in personnel

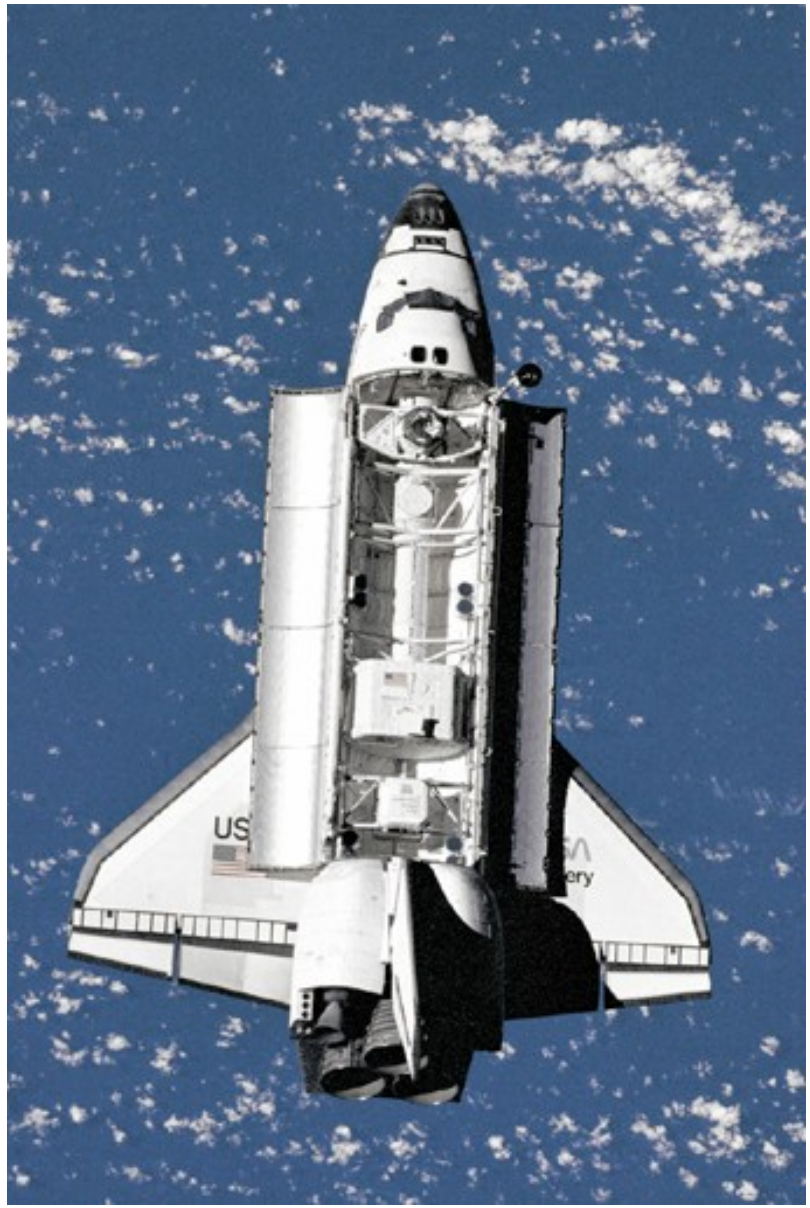
Space Shuttle
1981-2010



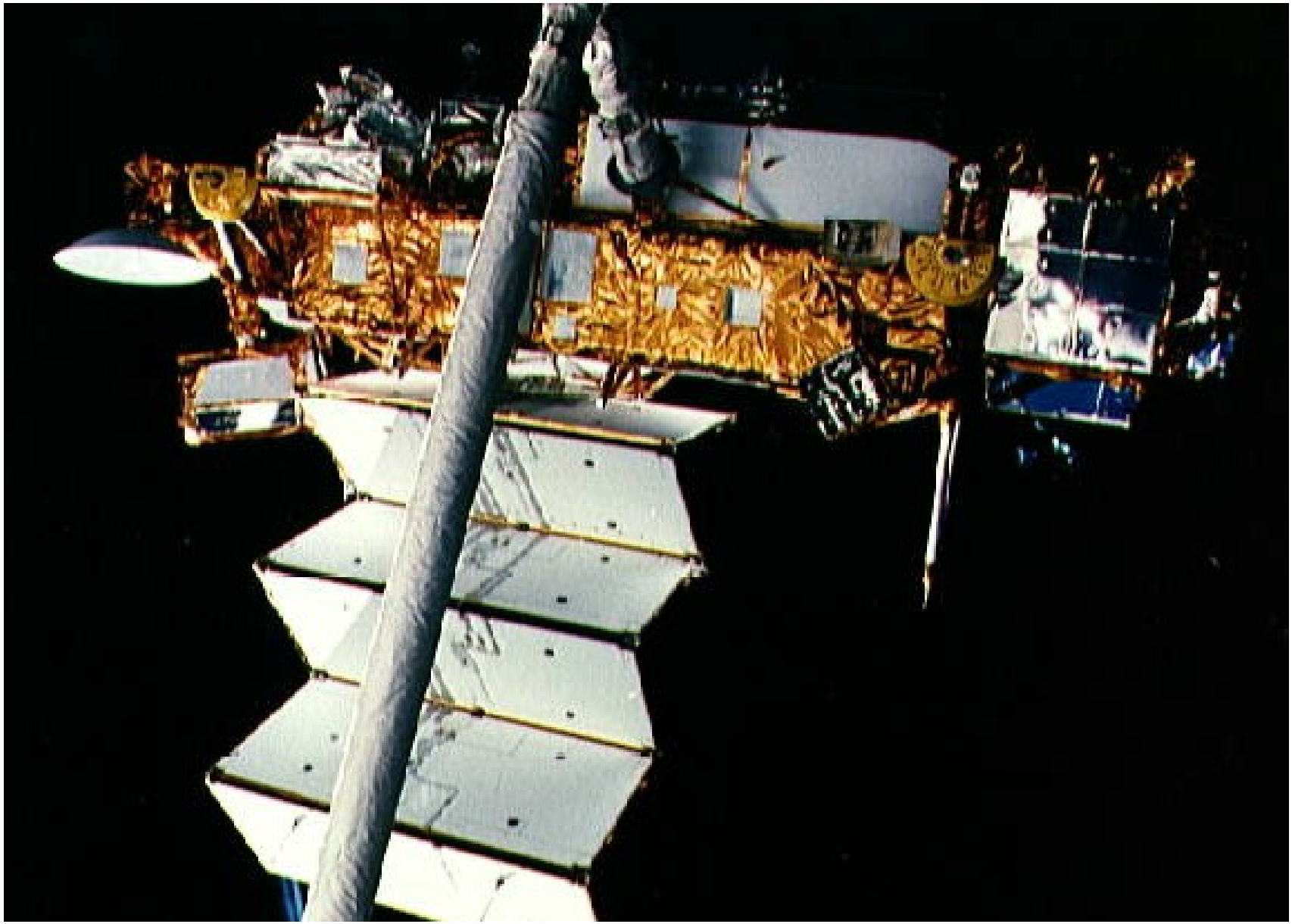
The space shuttle is the world’s first reusable spacecraft.

Powered by two solid rocket motors and three main engines,
The shuttle generates 6.7 million pounds of thrust at liftoff.

The solids burn for two minutes and are then jettisoned and return to earth by parachute.



The main fuel tank is also jettisoned once the shuttle reaches orbit and burns up on re-entry to the earth's atmosphere.



The payload bay is used to carry satellites to orbit and large enough to contain 5 Apollo command modules.

The shuttle mechanical arm is used with astronauts to build the space station.

“Houston, we have a problem…”

- **Significant gap between Apollo and Shuttle**
- **Complete turnover in the workforce**
- **Major jump in system complexity**
- **Lessons learned not easily accessible**
- **First use of re-useable components**
- **Payloads include other space vehicles**
- **Heavy emphasis on EVA**
- **Aggressive launch schedule**
- **Complex training for entire shuttle team**
- **Paper based system**
- **Program duration of 29 years!**

International Space Station
1998-Future

The first International Space Station modules were launched in 1998 with the first crew arriving in 2000.

ISS010E19151

Space station is supported by both the space shuttle and the Russian Soyuz vehicles.

S104E5121 2001/07/16 10:46:06

The International Space Station is a large facility designed to stay in orbit for 15+ years once completed.

ISS009E17439_NR

Space station houses a crew of three for stays of 3 months or more.

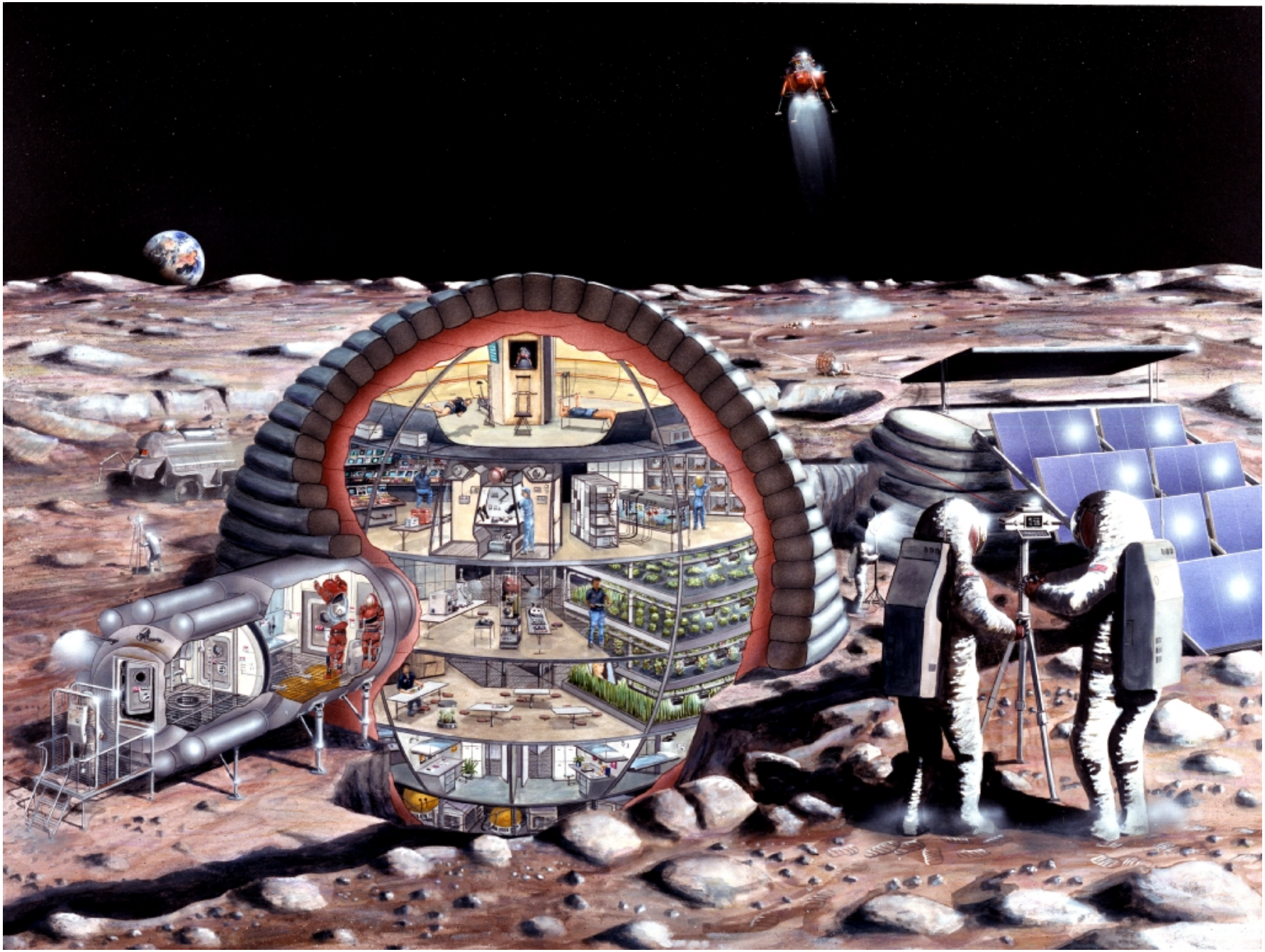
ISS009E18507

Space station has its own mechanical arm which is operated using video cameras since there are few windows.

PBMA Arrives

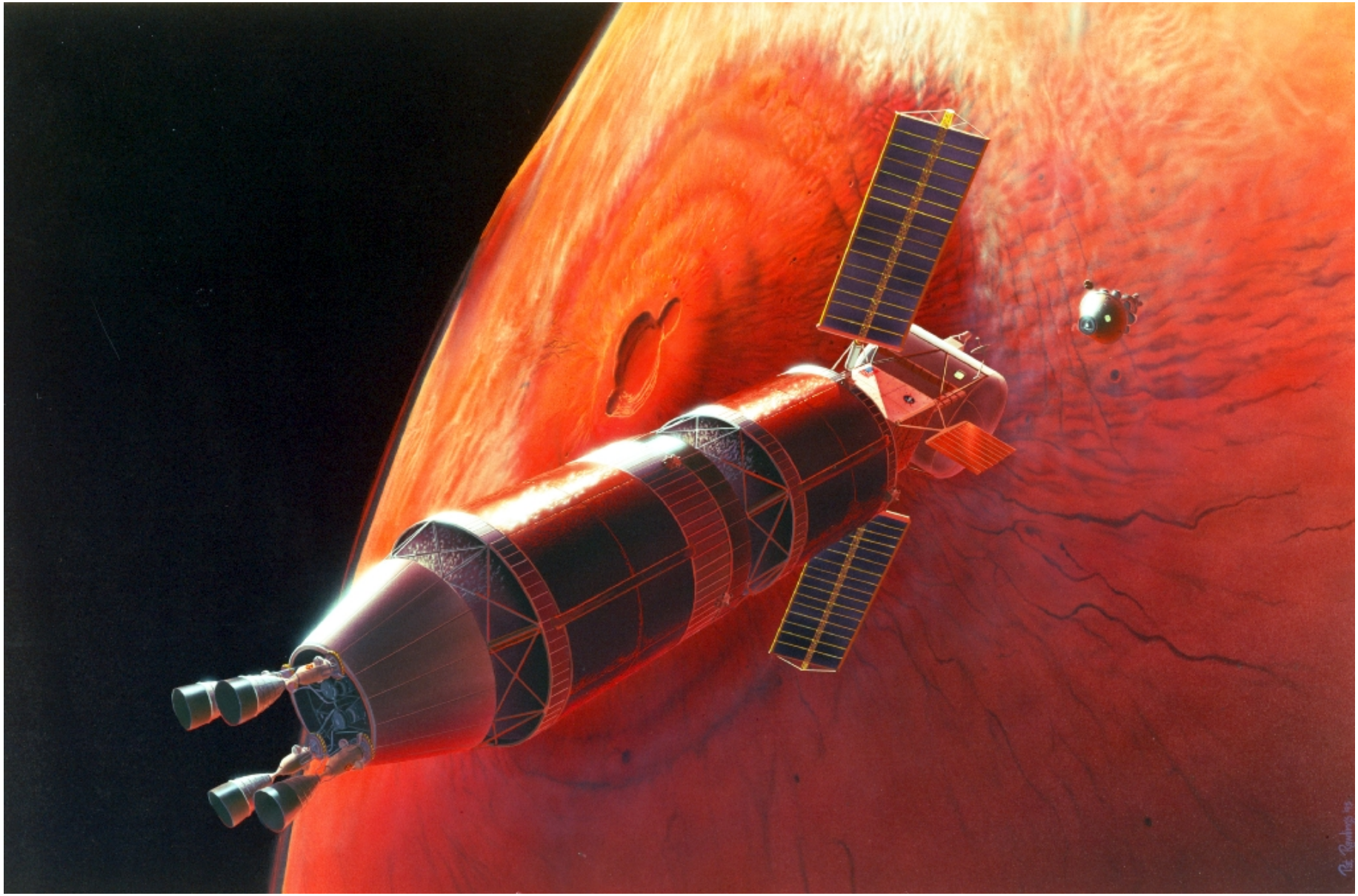
- **Paper based systems no longer viable**
- **Geographically distributed, dynamic team**
- **New enabling capabilities in information technology**
- **Need for “data-centric program management” unavoidable**
- **True long duration spaceflight implies just-in-time training**
- **Dynamic staffing**
- **Real time reach back mandatory**
- **There is only one way to keep everyone on the same sheet of music: PBMA**

The Future



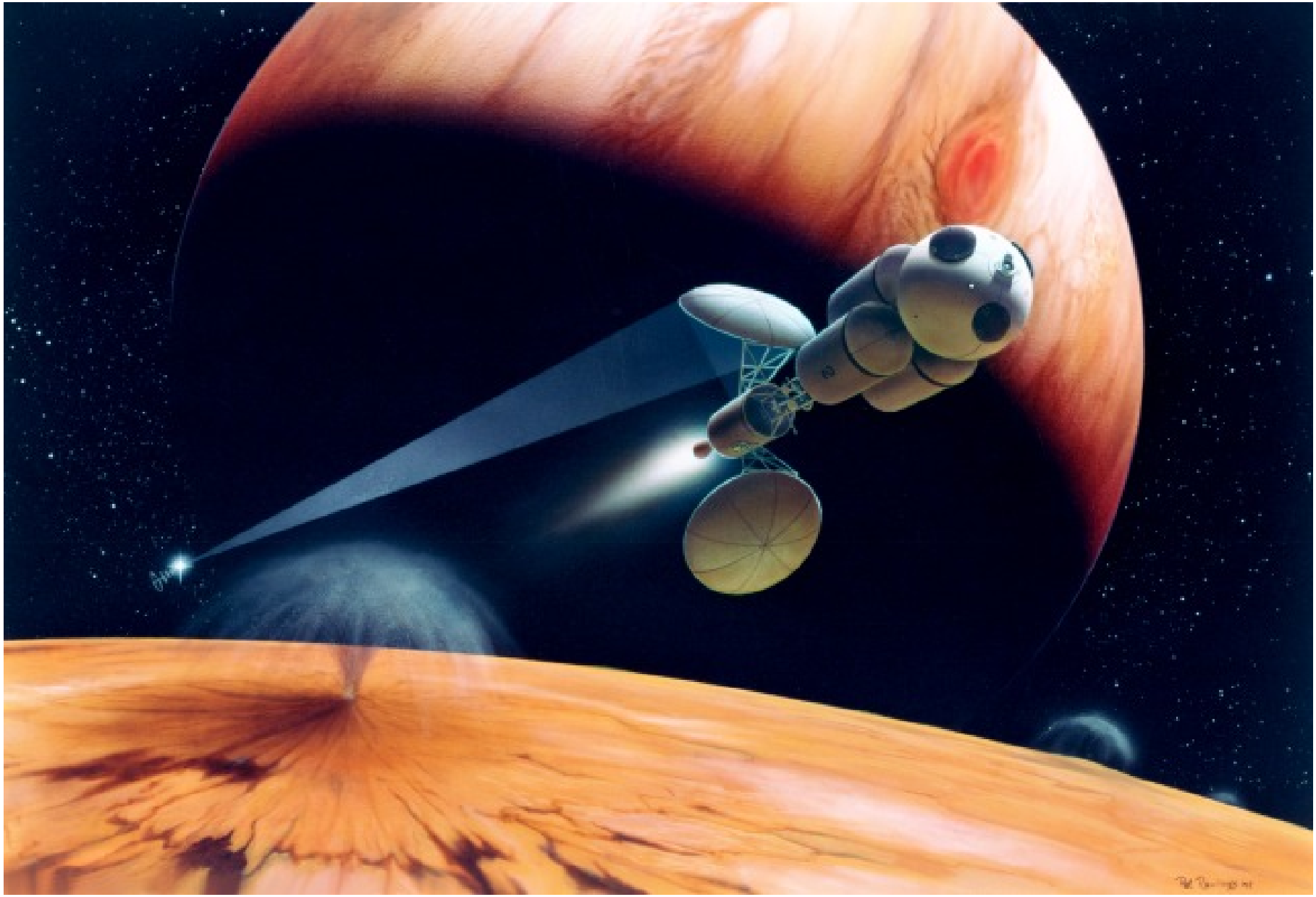
Our renewed emphasis on exploration will take us back to the Moon.

What we will do there is limited only by our imagination.



Sending people to Mars will probably occur in our lifetimes.

There are many challenges ahead and many discoveries to be made.



All these worlds are ours to explore!

Yoda of Dagobah

“My ally is PBMA, and a powerful ally it is. It is what gives all members of a program their power. It surrounds us, penetrates us. It binds the universe together.”